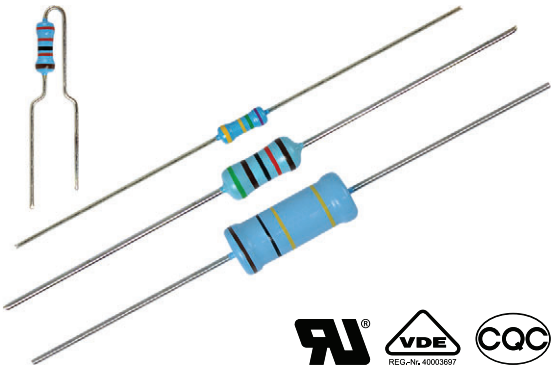
High Ohmic / High Voltage Metal Glaze Leaded Resistors



FEATURES

- UL approved (UL1676, file no: E171160)
- Meet the safety requirements of:
  - IEC 62368-1
  - VDE 0868-1
  - CQC (China)
- AEC-Q200 qualified available (VR25, VR37): on request for selected parts
- High pulse loading capability (maximum 10 kV)
- Radial version available for VR25
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

RoHS COMPLIANT

HALOGEN FREE

LINKS TO ADDITIONAL RESOURCES

3D Models

A metal glazed film is deposited on a high grade ceramic body. After a helical groove has been cut in the resistive layer, tinned electrolytic copper wires are welded to the end-caps. The resistors are coated with a light blue lacquer which provides electrical, mechanical, and climatic protection. This coating is not resistant to aggressive fluxes and cleaning solvents. The encapsulation is resistant to all cleaning solvents in accordance with IEC 60068-2-88.

APPLICATIONS

- Where high resistance, high stability, and high reliability at high voltage are required
- High humidity environment
- White goods
- Power supplies
- Automotive electronics

TECHNICAL SPECIFICATIONS

DESCRIPTION	VR25	VR37	VR68
DIN size	0207	0309	0718
Resistance range (1)	100 kΩ to 22 MΩ	100 kΩ to 33 MΩ	100 kΩ to 68 MΩ
Resistance tolerance	± 10 %; ± 5 %; ± 1 %		
Temperature coefficient	≤ ± 200 ppm/K		
Rated dissipation, P_{70}	0.25 W	0.5 W	1.0 W
Operating voltage, $U_{max.}$ AC_{RMS}/DC	1600 V	3500 V	10 000 V
Operating temperature range	-55 °C to +155 °C		
Permissible film temperature	155 °C		
Thermal resistance (R_{th})	140 K/W	120 K/W	70 K/W
Insulation voltage: 1 min.; U_{ins}	700 V		
Maximum noise (white noise)	5 µV/V	2.5 µV/V	2.5 µV/V
Max. resistance change at rated dissipation for resistance range, $\|\Delta R/R\|$ max., after 1000 h	1.5 %		

Note

(1) Ohmic values (other than resistance range) are available on request

SAFETY REQUIREMENTS AND QUALIFICATIONS

DESCRIPTION	VR25, VR37	VR37	VR68
Safety requirements / qualifications	AEC-Q200 (available on request for selected parts)	UL1676 qualification (file no: E171160) for ohmic range 510 kΩ to 11 MΩ; DIN EN IEC 62368-1 (VDE 0868-1):2021-05 Annex G.10; CQC11-471212-2012 and GB8898-2011	

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TEMPERATURE COEFFICIENT AND RESISTANCE RANGE

TYPE	TCR	TOLERANCE	RESISTANCE	E-SERIES
VR25	≤ ± 200 ppm/K	± 1 %	100 kΩ to 15 MΩ	E24; E96
		± 5 %	100 kΩ to 22 MΩ	E24; E96
		± 10 %	15 MΩ to 22 MΩ	E24
VR37		± 1 %	100 kΩ to 33 MΩ	E24; E96
		± 5 %	100 kΩ to 33 MΩ	E24
VR68		± 1 %	100 kΩ to 9.1 MΩ	E24; E96
		± 5 %	100 kΩ to 68 MΩ	E24

PACKAGING

TYPE	CODE	QUANTITY	PACKAGING STYLE	WIDTH	PITCH	PACKAGING DIMENSIONS
VR25	A1	1000	Taped according to IEC 60286-1 fan-folded in a box	53 mm	5 mm	75 mm x 31 mm x 260 mm
	A5	5000		53 mm	5 mm	76 mm x 105 mm x 265 mm
	N4	4000	Taped according to IEC 60286-2 fan-folded in a box	-	12.7 mm	48 mm x 253 mm x 330 mm
	R5	5000	Taped according to IEC 60286-1 on a reel	53 mm	5 mm	93 mm x 300 mm x 298 mm
VR37	A1	1000	Taped according to IEC 60286-1 fan-folded in a box	53 mm	5 mm	72 mm x 60 mm x 258 mm
	R5	5000	Taped according to IEC 60286-1 on a reel	53 mm	5 mm	90 mm x 375 mm x 375 mm
VR68	AC	500	Taped according to IEC 60286-1 fan-folded in a box	66 mm	10 mm	68 mm x 165 mm x 258 mm
	RD	750	Taped according to IEC 60286-1 on a reel	66 mm	10 mm	105 mm x 315 mm x 305 mm

PART NUMBER AND PRODUCT DESCRIPTION

PART NUMBER: VR25000001003FA100

V	R	2	5	0	0	0	0	0	1	0	0	3	F	A	1	0	0

TYPE / SIZE	VARIANT	TCR	RESISTANCE	TOLERANCE (1)	PACKAGING	SPECIAL
VR25000 = VR25 **VR37000** = VR37 **VR68000** = VR68	**0** = neutral	**0** = standard	**3 digit value** **1 digit multiplier** MULTIPLIER **3** = *10^3 **4** = *10^4 **5** = *10^5	**F** = ± 1 % **J** = ± 5 % **K** = ± 10 %	**A1** **AC** **A5** **RD** **R5** **N4**	**00** = standard

PRODUCT DESCRIPTION: VR25 1 % A1 100K

VR25	1 %	A1	100K
TYPE / SIZE	TOLERANCE	PACKAGING	RESISTANCE
VR25 **VR37** **VR68**	**± 1** % **± 5** % **± 10** %	**A1** **AC** **A5** **RD** **R5** **N4**	**100K** = 100 kΩ **15M** = 15 MΩ

Note

(1) See table “Temperature Coefficient and Resistance Range” for selecting correct ohmic value - tolerance combination

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DESCRIPTION

Production is strictly controlled and follows an extensive set of instructions established for reproducibility. A homogeneous film of metal glaze is deposited on a high grade ceramic body and conditioned to achieve the desired temperature coefficient. Plated steel termination caps are firmly pressed on the metalized rods. Mostly, a special laser is used to achieve the target value by smoothly cutting a helical groove in the resistive layer without damaging the ceramics. Connecting wires of electrolytic copper plated with 100 % pure matte tin are welded to the termination caps. The resistor elements are covered by a light blue protective coating designed for electrical, mechanical, and climatic protection. Four or five color code rings designate the resistance value and tolerance in accordance with **IEC 60062**.

Yellow and gray color code rings are used instead of gold and silver because metal particles in the lacquer could affect high-voltage properties.

The result of the determined production is verified by an extensive testing procedure performed on 100 % of the individual resistors. Only accepted products are stuck directly on the adhesive tapes in accordance with **IEC 60286-1** or for the radial versions in accordance with **IEC 60286-2**.

MATERIALS

Vishay acknowledges the following systems for the regulation of hazardous substances:

- IEC 62474, Material Declaration for Products of and for the Electrotechnical Industry, with the list of declarable substances given therein (1)
- The Global Automotive Declarable Substance List (GADSL) (2)
- The REACH regulation (1907/2006/EC) and the related list of substances with very high concern (SVHC) (3) for its supply chain

The products do not contain any of the banned substances as per IEC 62474, GADSL, or the SVHC list, see www.vishay.com/how/leadfree.

Hence the products fully comply with the following directives:

- 2000/53/EC End-of-Life Vehicle Directive (ELV) and Annex II (ELV II)
- 2011/65/EU Restriction of the Use of Hazardous Substances Directive (RoHS) with amendment 2015/863/EU
- 2012/19/EU Waste Electrical and Electronic Equipment Directive (WEEE)

Vishay pursues the elimination of conflict minerals from its supply chain, see the Conflict Minerals Policy at www.vishay.com/doc?49037.

ASSEMBLY

The resistors are suitable for processing on automatic insertion equipment and cutting and bending machines. Excellent solderability is proven, even after extended storage. They are suitable for automatic soldering using wave or dipping.

The resistor terminations are completely lead (Pb)-free, the pure matte tin plating provides compatibility with lead (Pb)-free and lead-containing soldering processes. The immunity of the plating against tin whisker growth, in compliance with IEC 60068-2-82, has been proven under extensive testing.

The encapsulant is resistant to cleaning solvent specified in IEC 60115-1. The suitability of conformal coatings, if applied, shall be qualified by appropriate means to ensure the long-term stability of the whole system.

APPROVALS

These resistors meet the safety requirements of:

- UL1676 (510 kΩ to 11 MΩ); file no: E171160
- IEC 62368-1
- VDE 0868-1
- CQC, China

RELATED PRODUCTS

For a correlated range of Metal Film Resistors see the datasheet:

“High Ohmic / High Voltage Metal Film Leaded Resistors”, www.vishay.com/doc?30260

For product that offers high power dissipation and metal oxide film technology see the datasheet:

“High Power Metal Oxide Leaded Resistors”, www.vishay.com/doc?20128

Notes

(1) The IEC 62474 list of declarable substances is maintained in a dedicated database, which is available at http://std.iec.ch/iec62474

(2) The Global Automotive Declarable Substance List (GADSL) is maintained by the American Chemistry Council, and available at www.gadsl.org

(3) The SVHC list is maintained by the European Chemical Agency (ECHA) and available at http://echa.europa.eu/candidate-list-table

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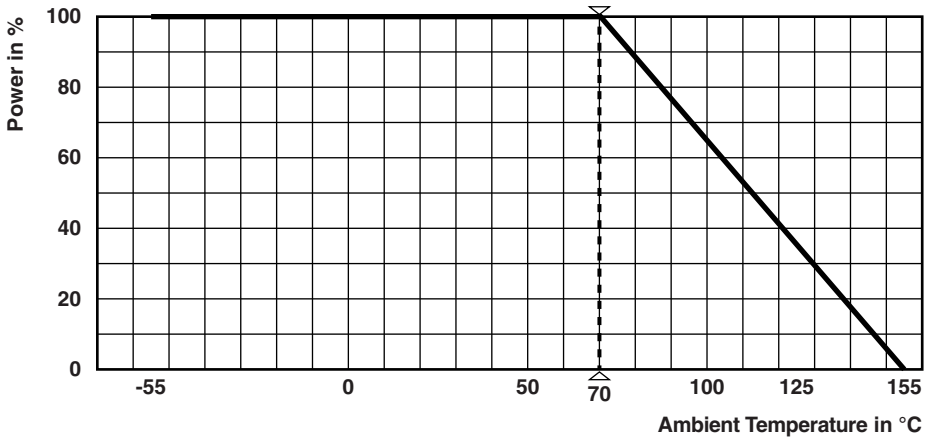
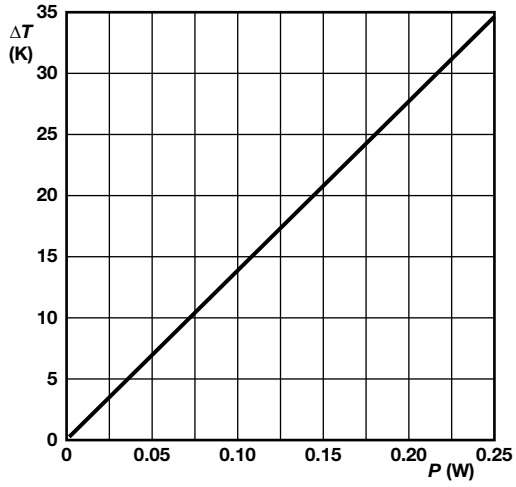
FUNCTIONAL PERFORMANCE

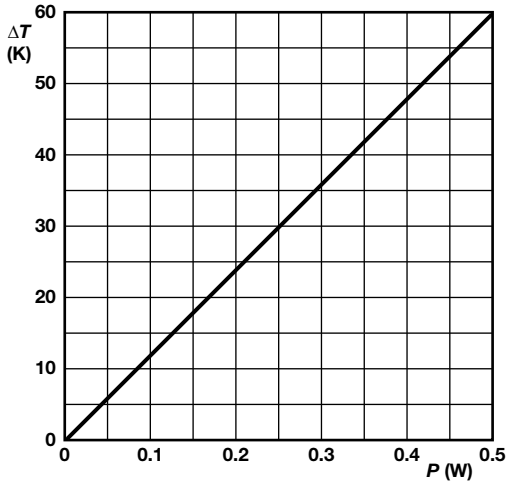
Derating



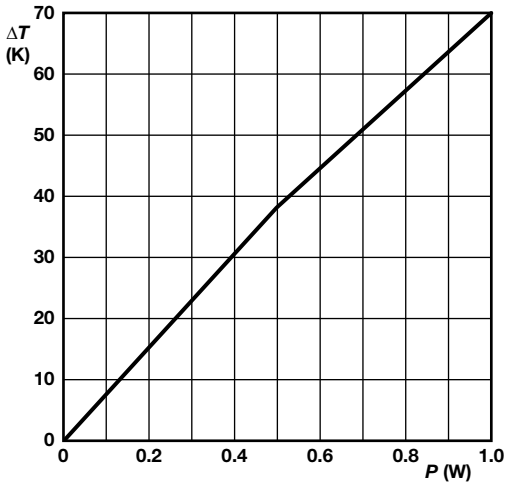
Hot-Spot Temperature Rise (ΔT) as a Function of Dissipated Power



VR25



VR37



VR68

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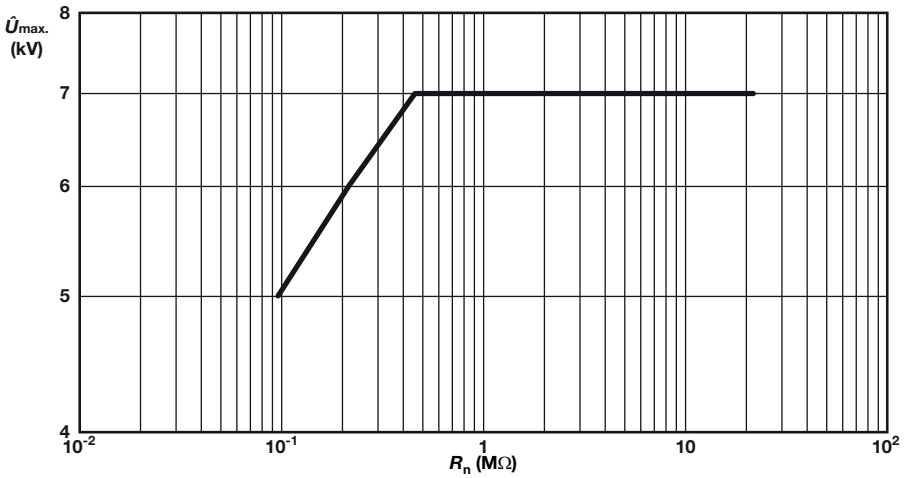
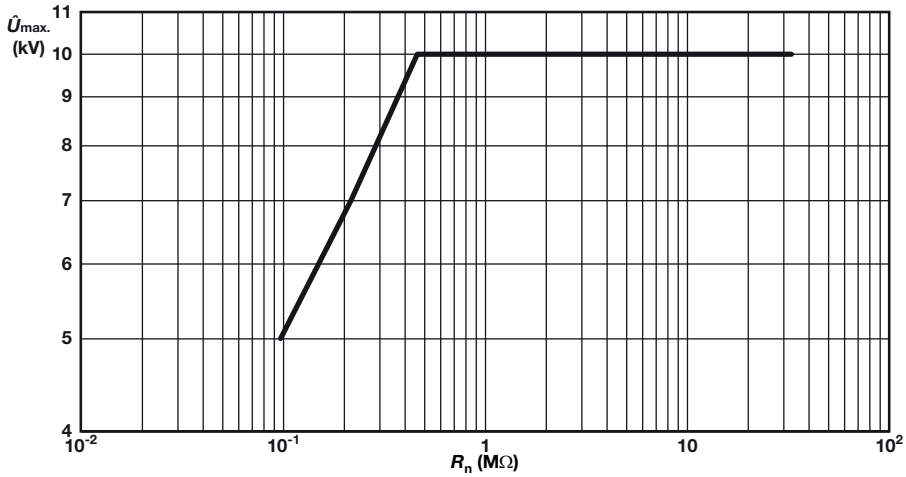
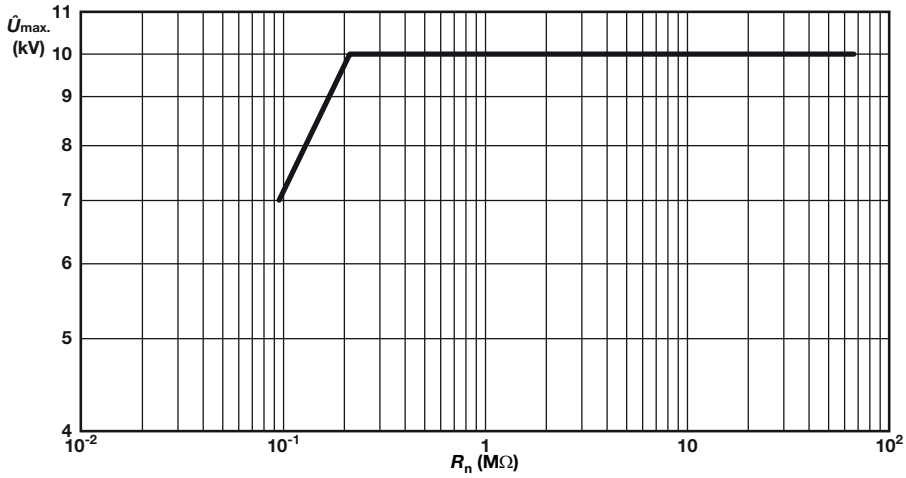
Maximum allowed peak pulse voltage in accordance with IEC 62368-1, G.10);
50 discharges from a 1 nF capacitor charged to $\hat{U}_{max.}$; 12 discharges/min (drift $\Delta R/R \leq 2$ %)



VR25



VR37



VR68

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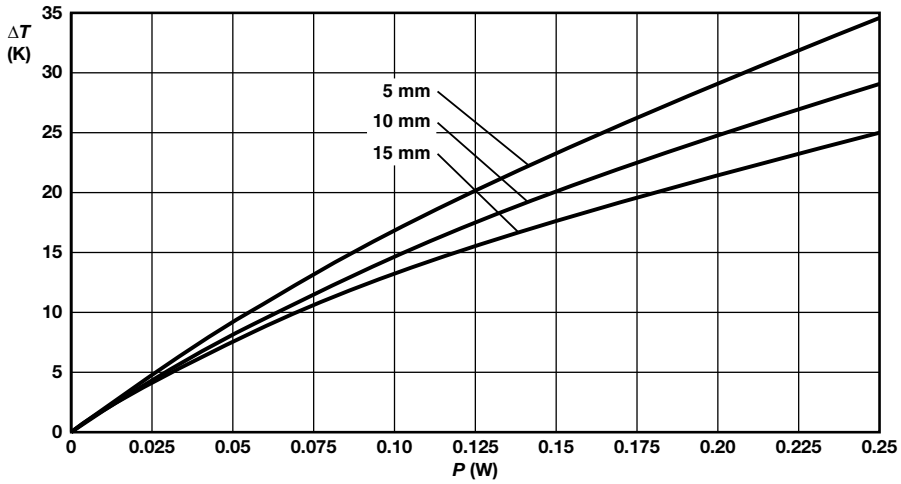
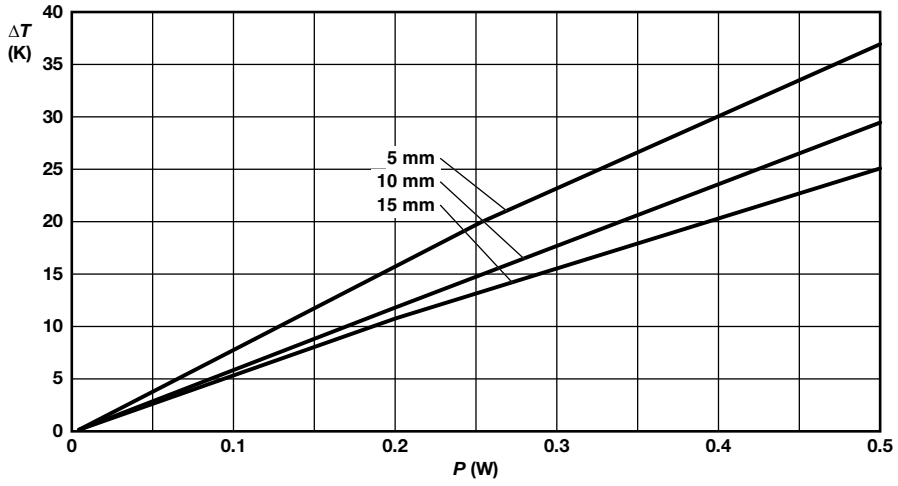
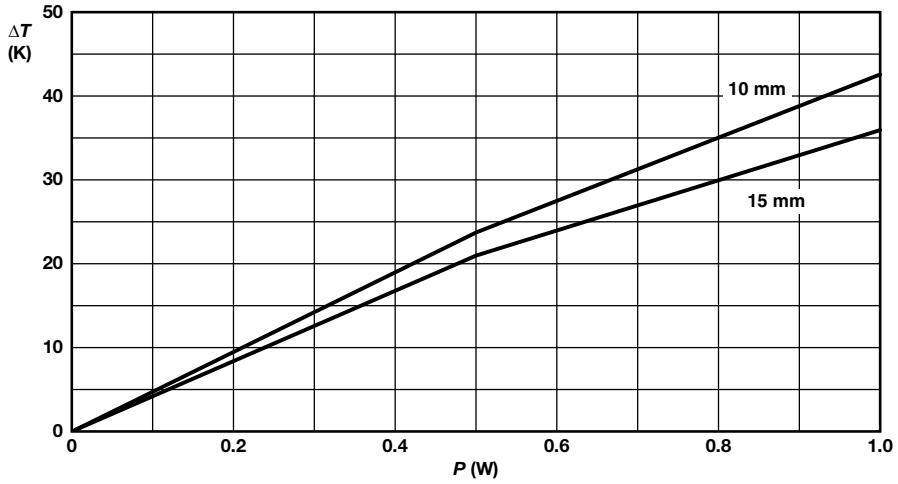
Temperature Rise (ΔT) at the Lead End (Soldering Point) as a Function of Dissipated Power at Various Lead Lengths after Mounting



VR25



VR37



VR68

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TESTS PROCEDURES AND REQUIREMENTS

All tests are carried out in accordance with the following specifications:

- EN 60115-1, generic specification
- IEC 60068-2-xx, test methods

The table presents only the most important tests, for the full test schedule refer to the documents listed above. However, some additional tests and a number of improvements against those minimum requirements have been included. The tests are carried out under standard atmospheric conditions in accordance with IEC 60068-1, 4.3, whereupon the following values are applied:

Temperature: 15 °C to 35 °C

Relative humidity: 25 % to 75 %

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar)

A climatic category LCT/ UCT / 56 is applied, defined by the lower category temperature (LCT = -55 °C), the upper category temperature (UCT = 155 °C), and the duration of exposure in the damp heat, steady state test (56 days). The components are mounted for testing on printed circuit boards in accordance with IEC 60115-1, 5.5 unless otherwise specified.

TESTS PROCEDURES AND REQUIREMENTS

IEC 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ($\Delta R_{max.}$)
12.1		Insulation resistance	$U_{max.}$ DC = 500 V during 1 min; V-block method	R_{ins} min.: 10 000 MΩ
12.2		Voltage proof	$U_{RMS} = U_{ins}$; 60 s	No breakdown or flashover
6.2		Temperature coefficient	At (20 / -55 / 20) °C and (20 / 155 / 20) °C	≤ ± 200 ppm/K
6.6		Current noise	IEC 60195	VR25: max. 5 µV/V VR37: max. 2.5 µV/V VR68: max. 2.5 µV/V
8.1		Short term overload	Room temperature; 2.5 x $\sqrt{P_{70} \times R}$; (voltage not more than 2 x limiting voltage); 10 cycles; 5 s ON and 45 s OFF	ΔR max.: ± 2 % R
9.5	21 (Ua1) 21 (Ub) 21 (Uc)	Robustness of terminations	Tensile, bending, and torsion	No damage ΔR max.: ± 0.5 % R
11.1	20 (Ta)	Solderability	+235 °C; 2 s; solder bath method; SnPb40 +245 °C; 3 s; solder bath method; SnAg3Cu0.5 (before aging)	Good tinning (≥ 95 % covered); no damage
			+235 °C; 2 s; solder bath method; SnPb40 +245 °C; 3 s; solder bath method; SnAg3Cu0.5 (after aging)	Good tinning (≥ 95 % covered); no damage
11.2	20 (Tb)	Resistance to soldering heat	Unmounted components (260 ± 5) °C; (10 ± 1) s	ΔR max.: ± 0.5 % R
10.1	14 (Na)	Rapid change of temperature	30 min at -55 °C and 30 min at +155 °C; 5 cycles	ΔR max.: ± 0.5 % R
9.9	27 (Ea)	Bump	3 x 1500 bumps in 3 directions; 40 g	No damage ΔR max.: ± 0.5 % R
9.11	6 (Fc)	Vibration	10 sweep cycles per direction; 10 Hz to 2000 Hz; 1.5 mm or 200 m/s^2	No damage ΔR max.: ± 0.5 % R
10.3		Climatic sequence:		R_{ins} min.: 1 GΩ ΔR max.: ± 1.5 % R
10.3.4.2	2 (Bb)	Dry heat	16 h; 155 °C	
10.3.4.3	30 (Db)	Damp heat (accelerated) 1st cycl	24 h; 25 °C to 55 °C; 90 % to 100 % RH	
10.3.4.4	1 (Ab)	Cold	2 h; -55 °C	
10.3.4.5	13 (M)	Low air pressure	1 h; (1 ± 0.1) kPa; 15 °C to 35 °C	
10.3.4.6	30 (Db)	Damp heat remaining cyclic	5 days; 55 °C; 95 % to 100 % RH; 5 cycles	
10.3.4.7		DC load	Apply rated power for 1 min	

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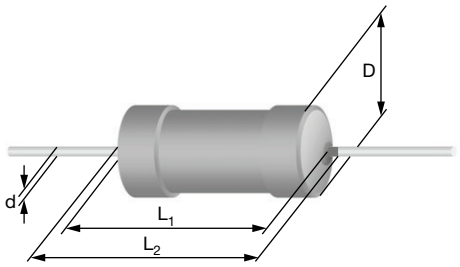
TESTS PROCEDURES AND REQUIREMENTS				
IEC 60115-1 CLAUSE	**IEC 60068-2 TEST METHOD**	**TEST**	**PROCEDURE**	**REQUIREMENTS PERMISSIBLE CHANGE ($\Delta R_{max.}$)**
10.4	78 (Cab)	Damp heat (steady state)	56 days; 40 °C; 90 % to 95 % RH; loaded with 0.01 P_{70} (steps: 0 V to 100 V)	ΔR max.: ± 1.5 % R
7.1		Endurance (at 70 °C)	1000 h; loaded with P_{70} or $U_{max.}$; 1.5 h ON and 0.5 h OFF	ΔR max.: ± 1.5 % R
12.3		Active flammability "cheese-cloth test"	Steps of: 5 / 10 / 16 / 25 / 40 x P_{70} duration 5 min	VR25: no flaming of gauze cylinder VR68: no flaming of gauze cylinder
12.4		Passive flammability "needle-flame test"	Application of test flame for 20 s	No ignition of product; no ignition of under-layer; burning time less than 30 s

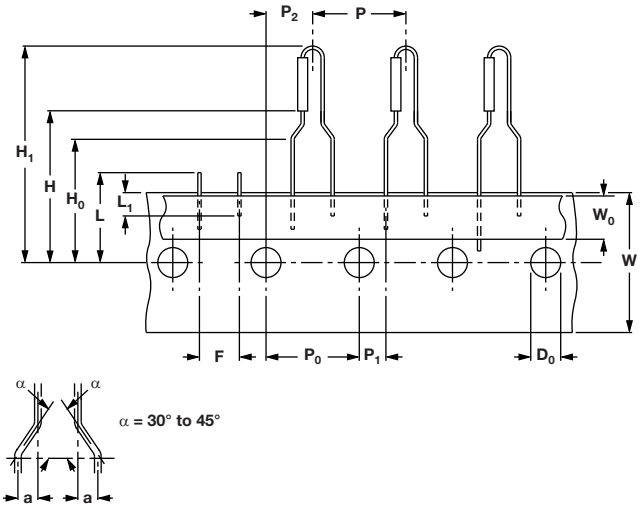
DIMENSIONS



DIMENSIONS - Leaded resistor types, mass, and relevant physical dimensions					
TYPE	**Ø $D_{max.}$ (mm)**	**$L_{1\ max.}$ (mm)**	**$L_{2\ max.}$ (mm)**	**Ø d (mm)**	**MASS (mg)**
VR25	2.5	6.5	7.5	0.58 ± 0.05	212
VR37	4.0	9.0	12.0	0.70 ± 0.03	457
VR68	6.8	18.0	19.0	0.78 ± 0.05	1690

VR25 WITH RADIAL TAPING

Lead Spacing (F = 4.8 mm), Size 0207



DIMENSIONS in millimeters		
Pitch of components	P	12.7 ± 1.0
Lead spacing	F	4.8 + 0.7 / - 0.0
Width of carrier tape	W	18.0 ± 0.5
Body to hole center	H	19.5 ± 1.0
Height for cutting (max.)	L	11
Height for bending	H_0	16.5 ± 0.5
Component height (max.)	H_1	29

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HISTORICAL 12NC INFORMATION

- The resistors have a 12-digit numeric code starting with
  - 2322 241 refers to VR25
  - 2322 242 refers to VR37
  - 2322 244 refers to VR68
- The subsequent first digit for 1 % tolerance products (E24 and E96 series) or 2 digits for 5 % (E24 series) and 10 % (E12 series) indicate the resistor type and packing
- The remaining digits indicate the resistance value:
  - The first 3 digits for 1 % or 2 digits for 5 % and 10 % tolerance products indicate the resistance value
  - The last digit indicates the resistance decade

Last Digit of 12NC Indicating Resistance Decade

RESISTANCE DECADE	LAST DIGIT
100 kΩ to 976 kΩ	4
1 MΩ to 9.76 MΩ	5
≥ 10 MΩ	6

Historical 12NC Example

- The 12NC for a VR25, resistor value 7.5 MΩ, 5 % tolerance, supplied on a bandoleer of 1000 units in ammopack, is: 2322 241 13755.
- The 12NC for a VR37, resistor value 7.5 MΩ, 5 % tolerance, supplied on a bandoleer of 1000 units in ammopack, is: 2322 242 13755.
- The 12NC for a VR68, resistor value 7.5 MΩ, 5 % tolerance, supplied on a bandoleer of 500 units in ammopack, is: 2322 244 13755.

12NC CODING FOR VR25, VR37, VR68 - Resistor type and packaging

TYPE	TOLERANCE (%)	VR25 CODING STARTS WITH 2322 241 ..... VR37 CODING STARTS WITH 2322 242 ..... VR68 CODING STARTS WITH 2322 244					
		BANDOLIER IN AMMOPACK				BANDOLIER ON REEL	
		RADIAL TAPED	STRAIGHT LEADS				
		4000 UNITS	52 mm	52 mm	66.7 mm	52 mm	66.7 mm
			1000 UNITS	5000 UNITS	500 UNITS	5000 UNITS	750 UNITS
VR25	± 1	0....	8....	7....	-	6....	-
	± 5	36...	13...	53...	-	23...	-
	± 10	38...	12...	52...	-	22...	-
VR37	± 1	-	8....	-	-	6....	-
	± 5	-	13...	-	-	23...	-
VR68	± 1	-	-	-	8....	-	6....
	± 5	-	-	-	13...	-	23...

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